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Abstract

The Orbiting Ozone and Aerosol Monitor (OOAM) is a small but capable instrument which monitors key properties of the stratosphere and mesosphere by using the solar occultation technique. OOAM is a potential payload for one of the USAF Space Test Experiments Platforms (STEP), which are typically launched *via* an Air Force Small Launch Vehicle. The OOAM instrument is described, together with the design of a STEP spacecraft which could carry OOAM and two other small payloads. The STEP design and program philosophy provide significant economies both for the payloads and for spacecraft fabrication and launch.

Introduction

The Orbiting Ozone and Aerosol Monitor (OOAM) is an instrument which monitors key properties of the stratosphere and mesosphere by measuring the attenuation of sunlight through the Earth's atmosphere. OOAM is a potential payload for one of the USAF Space Test Experiments Platforms (STEP), which are typically launched *via* an Air Force Small Launch Vehicle. A STEP spacecraft, including OOAM and two other small payloads, would weigh about 565 lb.

OOAM measures the intensity of attenuated sunlight in nine narrow spectral intervals between 350 and 1100 nm, and has wide-field and narrow-field Sun-sensors

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which drive a servo system to track the Sun's center of brightness. OOAM is similar to another instrument, the Polar Ozone and Aerosol Measurement (POAM-II) instrument[1], which is operating onboard the SPOT-3 satellite. Presently-considered STEP platforms would have an orbital inclination of 70°, and SPOT-3 has a Sun-synchronous orbit with an inclination of about 98°, so that together OOAM and POAM-II would provide nearly global coverage. OOAM's Sun-tracking system would allow it to accurately track the Sun while making only modest demands on the STEP attitude control system.

OOAM: Principles of Operation

OOAM measures vertical profiles of ozone, nitrogen dioxide, water vapor, aerosol properties and temperature in the stratosphere. These properties are inferred from the changing attenuation of sunlight as the line of sight to the Sun sweeps through a range of altitudes as the instrument sees the Sun rise or set through the Earth's atmosphere on each orbit. For typical altitudes (700 to 800 km), there are about 14 orbits per day: at times when the plane of the orbit passes though the Earth's shadow, there are thus about 14 sunrises and 14 sunsets per day.

This method automatically calibrates out any long-term drifts in the instrument's transmittance and responsivity, because the signal obtained for a line of sight traversing the atmosphere is normalized by that for unattenuated lines of sight during the same sunrise or sunset event. Any slow change in the magnitude of the peak transmittance or detector responsivity of a spectral channel will affect both signals by the same factor, and will cancel out of the ratio. However, ratioing will not remove changes in the locations or widths of the passbands, so the instrument must be designed to minimize these types of changes.

A spectral channel, with its associated optics and electronics, will be called a "science channel" in what follows. In OOAM (and POAM), the science channels each view the Sun through a narrow slit, which is kept aimed at the Sun's center of brightness during most of the sunrise or sunset event. The slit's long axis views the full diameter of the Sun, and is kept parallel to the Earth's limb. For lines of sight only weakly attenuated and refracted by the Earth's atmosphere, the center of brightness of the Sun's image coincides with the Sun's geometric center. But for deeper lines of sight, differential attenuation and, to a lesser extent, refraction, raise the center of brightness of the Sun's image above the image of the Sun's true geometric center. The normalization (mentioned earlier) requires the signal for each attenuated line of sight to be divided by the signal for an unattenuated line of sight to the same portion of the Sun that provided the energy for the attenuated signal. But the unattenuated lines of sight obtained while tracking on the center of brightness are all pointed at the geometric center of the Sun, rather than at appropriately displaced portions of the solar disk. To determine the normalizing signals a scan is taken across the face of the unattenuated Sun. To use the scan it is necessary to know the appropriate displacement of each line of sight from the center of brightness. The displacement depends upon the differential attenuation and refraction for that line of sight, which in turn depends upon the vertical distribution of atmospheric properties which OOAM is

trying to determine. The displacement must therefore be determined iteratively. The iteration is initialized with a model atmosphere suitable for the time and place of the the observation, and the atmospheric model is adjusted until it is consistent with the data.

For scientific purposes, the time and refracted trajectory for each line of sight through the atmosphere must be known. Samples are time-tagged by a method described later. Given the time and the spacecraft's orbit, the known position of the Sun determines the direction of the straight line joining the spacecraft to the Sun. The refracted line of sight is determined iteratively, as indicated in the previous paragraph. Thus the spacecraft's attitude determination system is not needed for analyzing the data: accurate orbital position information is needed, rather than accurate attitude information. Satellite attitude control is needed only for finding the Sun at the beginning of each sunrise or sunset event.

POAM-II is designed to sample the polar atmosphere, and is in a polar, Sun-synchronous orbit. Every orbit traverses the Earth's shadow, producing sunrise and sunset events lasting about the same amount of time (90 seconds, including Sun acquisition and calibration scan). These brief events do not average the line of sight over an excessive range of latitudes, and hence are all useful scientifically. In contrast, OOAM is designed to sample the atmosphere at non-polar latitudes, and so cannot have a Sun-synchronous orbit. At certain times of year the orbit will not penetrate the Earth's shadow, or will penetrate only its edge, producing long sunrise and sunset events which average

over too wide a range of latitudes to be scientifically useful. Useful events can be obtained during most of the year, when the sunrises and sunsets are briefer. OOAM is designed for sunrise and sunset events lasting 3 minutes or less.

The OOAM Instrument

OOAM was developed by the Naval Research Laboratory (NRL); detailed design and fabrication is by Research Support Instruments (RSI). OOAM improves on the POAM-II design. NRL will reduce and validate the data, and will place the validated data in archives accessible to the public. The OOAM project is funded by the Strategic Environmental Research and Development Program (SERDP).

The OOAM instrument consists of an Optical Head Assembly (OHA) and a Primary Control Electronics Module (PCEM). The OHA (Figure 1) is a 2-axis gimballed assembly containing nine science channels, two Sun sensors, a microprocessor, and servo-controlled motors which operate the gimbals. The OHA is located on the outside of the spacecraft, where it can view the Earth's limb; thus the dome in Figure 1 points down from the spacecraft. The PCEM controls and powers the OHA, receives commands from the spacecraft, and transferring OOAM data to the spacecraft for storage and eventual downlinking. The PCEM and OHA communicate via a serial link. Digitized data samples acquired by the OHA are time-tagged by the PCEM clock, which is synchronized to UT time by means of a signal sent from the spacecraft to the PCEM every 30 seconds. Time-tagging will be accurate to within 50 milliseconds.

Each of the nine science channels in the OHA contains a focusing lens, a precision slit, a narrowband optical filter, and a silicon photodiode (Figure 2). The electronic signal from the photodiode is amplified, using any of four individually selectable gains. The amplified signals are filtered by a six-pole active electronic filter, and are multiplexed into a single data stream which is then digitized at a rate of 54 samples per science channel per second. The OHA's 80286 microprocessor digitally filters the science data and reduces the per-channel data rate to 18 samples per second. The serial stream also contains the signals from the Sun sensors and from three thermistors; the latter housekeeping signals are sub-multiplexed into the data stream. The digitized serial stream is sent to the PCEM.

OOAM is designed to be mounted on an Earth-pointing spacecraft. The azimuth gimbal provides rotation about the nadir-zenith (yaw) axis, and carries the Elevation Head. The Elevation Head contains the elevation gimbal, which provides rotation about an axis which is perpendicular to both the azimuth axis and to the instantaneous direction of look; a change in elevation corresponds to an azimuth-dependent combination of pitch and roll. The OHA can rotate 317° in azimuth and 15° in elevation. The azimuth and elevation gimbals are controlled by individual servo-controlled DC motors. Servo control can be based either on signals from continuous-film potentiometers or on signals from the Sun sensors. The servo uses the potentiometer signals when slewing to a predetermined direction, and uses the Sun sensor signals to track the Sun. In either case, velocity feedback from a tachometer is used to minimize overshoot and ringing. OOAM

has two Sun sensors, one with a wide (10°) field of view and one with a narrow (1°) field of view. The addition of the wide-field Sun sensor is an improvement on POAM-II, and relaxes the attitude control needed for acquiring the Sun. Each Sun sensor has a quad-cell silicon photodiode, whose signals are amplified, but not analog filtered, before being multiplexed into the serial data stream; after digitization the quad-cell signals are also not digitally filtered by the OHA's microprocessor. When the Sun is being acquired, the error signals in the servo loop come initially from the potentiometers. As soon as the sum of the signals from the quad cells exceeds a threshold, the error signals are taken from normalized differences of quad cell signals. When the total signal from the quad cells of the narrow-field Sun sensor exceeds a threshold, control passes from the wide-field to the narrow-field Sun sensor. OOAM can also be commanded to use only one of the two Sun sensors. When the Sun-sensors are used, the OHA tracks the center of brightness of the Sun.

The wavelengths detected by the nine science channels range from 355 nm to 1020 nm. Each science channel has a 0.01° by 0.75° field of view, created by the fused silica objective lenses in conjunction with the slits (Figure 2). The lenses are nearly plano-convex, but have an aspheric shape on the convex (Sun-facing) side to eliminate spherical aberration. The slit is fabricated by depositing an aluminum coating on a substrate of optical-quality fused silica, and then using laser evaporation to create a slit-shaped clear area having precise, smooth, parallel edges.

Each science channel is defined spectrally by an optical interference filter

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having a narrow bandpass: 2 to 15 nm, depending upon the channel. The filters use refractory metal-oxide coatings instead of conventional fluorides, and no epoxies. This choice of materials reduces chemical and solar degradation, a serious problem in space. Three or four multilayer "cavities" will be used in each interference filter, to provide extrememly rapid roll-off of the out-of-band transmittance. The filters are being fabricated by the Optical Corporation of America using their MicroPlasma₊ coating technology. This energetic plasma-based deposition process solves the porosity problem of conventionally deposited hard coatings.

Light transmitted within the bandpass of the optical filters is detected by silicon photodiodes. These photodiodes are packaged with an anti-reflection (AR) coated quartz window and have enhanced spectral response in the near UV (340 nm). This increases ₊the quantum efficiency of the ₊channel with the shortest wavelength (355 nm) without degrading the responsivity at longer wavelengths. Thus, all the science channels can use the same type of photodiode.

The optical flux in each science channel is converted to an electronic voltage using the photodiode and a chopper-stabilized operational amplifier, in a photovoltaic, transimpedance configuration. The signal is then amplified by an operational amplifier circuit. The gain for each science channel is individually selectable amongst four values (0.5, 1, 1.4 and 2), and the selections can be revised by uplinked commands. The adjustability of the gains can be used to prevent saturation or to compensate for possible long-term reductions in signal strength due to

deposition and baking on of outgassed material or UV degradation of the optical filters. Amplification is followed by active analog filtering to reduce noise. A six-pole filter is used, with a 7.5 Hz cut-off frequency. After multiplexing, the signal is digitized with a 16-bit analog-to-digital converter.

The Sun-sensors have telephoto optics, and a colored glass red-pass filter, with a 700 nm cut-on. The image of the Sun is deliberately kept out of focus on the quad-cell detectors, to stabilize the signal from the Sun sensors against jitter. The red-pass filter minimizes changes of the output signal due to attenuation of short-wavelength light by the atmosphere; in particular, the red-pass filter makes the pointing by the Sun-sensor insensitive to the vertical distribution of ozone, by blocking 90% of the Chappuis band (600 nm) of ozone. The red-pass filter also minimizes refraction-induced deviations of the center of brightness of the Sun from its geometric center.

In addition to digitally filtering the science channel data, the OHA's microprocessor provides servo control of the azimuth and elevation motors. Science and housekeeping data from a sunrise or sunset event are sent from the OHA to the PCEM via the serial link between them.

The OHA is 8.5" wide by 11" long by 12.2" tall. It is fabricated of machined aluminum, is black anodized, and is covered with MLI blankets for thermal stabilization. The OHA is thermally isolated from the spacecraft. When a sunrise or sunset is not in process, the OHA is kept in a "safe" position, pointed away from both the spacecraft's ram direction and from the

direction of the Sun: sunlight entering the slits in the OHA's dome would cause unwanted heating.

The PCEM contains a modular power supply to regulate the 28 V provided by the spacecraft, and provide all secondary voltages needed by the instrument. The PCEM contains four plug-in cards which interface to a motherboard. The PCEM communicates with the spacecraft via a MIL-STD-1553B serial communication link; this link is used both for receiving commands from the spacrcraft and for transferring OOAM data to the spacecraft. The spacecraft is used for mass storage of data, and its telemetry system is used for downlinking the data. There are also two dedicated lines which convey two discrete commands to the PCEM from the spacecraft: a processor reset, and a power-down warning. On receipt of the power-down warning the OHA is slewed toward a safe position.

Twelve power and temperature monitoring signals, as well as the azimuth and elevation of the OHA, are relayed to the spacecraft in analog form, as state-of-health (SOH) indicators. The SOH data is sampled at a lower rate than the science data. The azimuth and elevation potentiometer readings are also sent digitally, at the same per-sample data rate as the science data, as part of the science data stream. The spacecraft will continuously monitor the SOH analog signals, and they will be displayed to the operator on the ground.

Since the OHA is thermally isolated from the spacecraft, there are thermostatically-controlled heaters in the OHA. The heaters prevent mechanical damage from prolonged differential cooling.

Survival temperatures for the OHA are -10° to +55°C. The safe-heaters are powered by an auxilliary 28 V line from the spacecraft; they are powered only when the main power to the instrument is off. Power for the safe-heaters is relayed to the OHA by control electronics in the PCEM.

AURA and DDIDM

The conceptual design of the spacecraft envisions three payloads: OOAM, AURA and DDIDM. AURA (Atmospheric Ultraviolet Radiance Analyzer)[2,3] measures UV emission between 115 and 190 nanometers, over much of the globe. AURA can obtain both images and spectra. AURA will make measurements on the aurora, the equatorial depletion zones, and the airglow. AURA is sponsored by the Air Force Phillips Laboratory Geophysics Directorate. DDIDM (Digital Dosimeter and Ion Driftmeter) consists of two instruments, a dosimeter and a drift meter, which measure electrons and ions at the spacecraft's altitude (725 km). The dosimeter uses an array of solid state detectors to measure the flux density and energies of electrons between 3 and 10 MeV and of protons between 35 and 75 Mev. The ion driftmeter measures the three components of the ion drift velocity vector for ions having speeds of 3000 m/sec or less, for ion number densities between 10^2 and $5 \cdot 10^6$ ions/cm^3. It operates by electrostatically focusing thermal ions onto a microchannel plate. Like AURA, DDIDM is sponsored by the Air Force Phillips Laboratory Geophysics Directorate.

AURA looks closer to the nadir direction than OOAM does. Direct sunlight must be avoided, to prevent damage to

AURA's detectors. Hence, although OOAM and AURA both look into the nadir hemisphere, they look in roughly opposite directions within that hemisphere. Each instrument must avoid reflections from the other, while OOAM must have acces to essentially all azimuths. Hence OOAM was placed on a pedestal, and AURA was provided with baffles, as shown in Figure 3.

The DDIDM dosimeter is mounted so that its detectors face into the zenith hemisphere. The DDIDM ion driftmeter is placed on the spacecraft so that its two co-planar apertures face along the spacecraft's velocity vector. The two DDIDM instruments are shown in Figure 3.

The presence of AURA and OOAM on the same spacecraft would permit a search for correlations between events in the upper and middle atmosphere. The presence of DDIDM and OOAM on the same spacecraft would be desirable because POAM-II experiences a large number of radiation-induced upsets, particularly over the South Atlantic Anomaly. DDIDM would provide correlative data for analyzing the causes of these upsets.

About once per month AURA must be calibrated on UV stars. To provide the requisite steadiness for finding these stars, instruments having moving parts, such as OOAM, must not use their motors prior to and during these calibrations. Fortunately, about half of these calibrations can be scheduled for times when the orbit does not cross the Earth's shadow, and OOAM cannot collect useful data anyway.

STEP Spacecraft

In the candidate spacecraft design, the host platform for OOAM would be a STEP spacecraft. The STEP family of spacecraft are sponsored by the USAF Space Test Program (STP). STP is in turn managed by the Space and Missile Systems Center (SMC) of the Air Force Materiel Command. STP's mission calls for it to provide spaceflight opportunities for research and development experiments which do not fund their own flights. STP is frequently the immediate provider of host platforms for such experiments. STP may also use other DoD or NASA platforms, including the Space Shuttle.

Four STEP spacecraft have previously been built; they were built by TRW's Space and Electronics Group and its chief subcontractor, CTA, Inc., under a contract awarded by SMC in April, 1990. Each STEP spacecraft is a modular bus which can carry one or more separate scientific instruments. Each space platform weighs between roughly 500 and 1000 pounds, including payloads and fuel. The spacecraft's orientation can be adapted to the needs of the payload; for the conceptual design for OOAM, the spacecraft would be nadir pointing. Mission 0 was launched on Orbital Science Corporation's Taurus, and Mission 2 was launched on an Pegasus Air Force Small Launch Vehicle (AFSLV).

STEP spacecraft are modular and light. The standardized core module includes all the subsystems (power, attitude control, telemetry/control) needed for independent flight. One or more specialized modules and/or selected subsystem enhancements are added to the core module to tailor the spacecraft to the needs of its

payloads. This modular approach avoids the cost and schedule penalties associated with a fully customized design. The modular approach allows concurrent fabrication, assembly, integration and test activities, which further shortens the schedule and reduces costs. The STEP philosophy for creating economical but highly versatile spacecraft is rounded out by the extensive use of flight-proven, off-the-shelf hardware, avoiding redundancy (where appropriate), a minimum inventory of spares, and modest requirements for documentation and formal program reviews.

Conceptual Design of a STEP Mission

The conceptual design of a mission carrying OOAM, AURA and DDIDM would augment the core STEP vehicle with three modules from the STEP inventory: (i) a payloaud module, housing the OOAM PCEM plus electronics for AURA and DDIDM; (ii) an adapter module, an annulus-shaped structure which serves as the physical interface between the spacecraft and its launch vehicle, and also supports the solar arrays and provides the mounting location required for DDIDM; and (iii) a deployment plate, which serves as the external mounting location for the OOAM OHA and for AURA.

The STEP family also offers a propulsion module, capable of carrying up to 170 pounds of hydrazine, for adjusting the orbit or attitude. This module would not be needed for the present mission, which will use reaction wheels and magnetic torquers.

STEP modules are constructed entirely of aluminum, for lightness and strength. The modules in the conceptual design would be circular or 12-sided cylinders of the same diameter, which readily yield a spacecraft having a simple, streamlined shape. The STEP modules together with the payloads would result in a complete space vehicle weighing approximately 565 pounds. The vehicle is shown in Figure 3.

Key Spacecraft Subsystems

The key subsystems of the candidate STEP mission are those for attitude control, electric power, thermal control, and command, control and telemetry.

Attitude Control

The attitude control system (ACS) for the candidate mission is very similar to the standard ACS for the core module. The ACS would consist of two scan wheels (reaction wheels with horizon sensors) and associated electronics, three orthogonal torque rods, a three-axis magnetometer, and a 6 MHz 80C186 processor. Pitch momentum bias would be used, that is, pitch and roll would be actively sensed, and the quarter-orbit coupling between roll and yaw would be used to control yaw. The scan wheels rotate at about 2000 RPM. The magnetometer and torque rods would be used for momentum management, and for stabilizing the platform under backup conditions.

Based on the aggregate requirements of the three payloads, the ACS would control roll and pitch to within $\pm 0.5°$ each, and yaw to within $\pm 1.0°$. Attitude would also be controlled to $\pm 1.2°$ about the OOAM OHA line of sight while OOAM is

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observing a sunrise or sunset. Attitude knowledge would be available to ±0.3° in roll and pitch (separately), and to ±1.0° in yaw. The drift in spacecraft attitude would be confined to less than ±0.5° (all axes) during the duration (up to three minutes) of a scientifically useful sunrise or sunset event. Attitude drift rates would be kept to less than 0.05°/sec over the same time intervals. To aid in the analysis of OOAM data, records of spacecraft scan wheel estimates of roll and pitch attitude errors, sampled every 10 seconds, would be provided to the OOAM ground operations team.

Three ACS modes are envisioned. They protect the spacraft under unusual conditions as well as providing the control needed under normal conditions. In the *normal* mode the scan wheel speeds are adjusted as needed, and the torque rods are used for momentum management. In the *safe hold* mode the scan wheels spin at a constant rate, and the torque rods operate under the "B dot" law. In the *survival* mode the scan wheels are turned off, but the torque rods continue to operate under the "B dot" law.

Electric Power

The power system for the candidate spacecraft is similar to the standard system for the core module, but takes advantage of specialized designs developed for earlier STEP missions. The power system can supply 138 W as an orbital average, under the most stressful combination of solar illumination geometry, battery capacity and load demand (spacecraft plus payloads). Of this total, OOAM would consume about 30.8 W, averaged over an orbit.

The candidate mission would use four 4 amp-hour NiCd battery packs, each provided with a charge regulator. Each payload instrument would be provided with 28±4 VDC power; lines at lower voltages would also be used for spacecraft-specific functions. Power would be switched to all of the payloads *via* the Main Power Control Unit.

Prime electric power would be generated by twelve 20×34 inch double-sided solar panels, arranged into four orthogonal arrays. The panels would employ conventional silicon solar cells mounted on Graphite-Fiber Reinforced Plastic (GFRP) substrates. The four panels would deploy after the spacecraft reached orbit, and would then assume fixed positions.

Thermal Control

Except for two small heaters, one inside the *OOAM OHA* and one external to *DDIDM*, thermal control would be passive. Selected insulating materials, finishes, and high-emittance coatings are used on components both inside and outside the spacecraft to maintain the temperature at each location within the desired range. The panels forming the sides of the spacecraft modules efficiently radiate heat from equipment mounted inside the modules. The bulkheads separating the stacked modules also function as heat sinks, radiatively interacting with all interior surfaces to moderate temperature extremes. A heat pipe on the bulkhead between the core and adapter modules also helps equalize heat loads. Blankets cover those exterior surfaces having high solar heat loads, and surfaces with low solar heat loads are coated with aluminized teflon. The safe heater in

the OOAM OHA ensures that the OHA remains above its survival limit of -10°C.

Command, Control and Telemetry

The methods, hardware, and software used for command and control would combine the standard capabilities of the STEP core module with several upgrades developed for STEP missions 0 through 3.

The principal components of the command and control systems would be the Command and Data Handler (CDH) and the Experiment Interface Processor (EIP). The CDH controls the spacecraft (including the ACS and power systems), collects state-of-health (SOH) data from the spacecraft and payloads, and receives, interprets, stores and executes commands. The CDH is also the interface to the spacecraft's main clock. The EIP controls the payloads, collects and stores scientific and housekeeping data from them, and formats the data for downlink. Thus the payloads need not store and format their own data. Both the CDH and the EIP would communicate separately and directly with ground control, using a packetized telemetry stream. The CDH downlinks SOH data at 32 kbps and uplinks commands at 1 kbps. The EIP downlinks at 1 Mbps, because there is much more science data than SOH data.

Both the CDH and the EIP employ redundant 6 MHz 80C186 processors. In addition, the EIP has 24 Mbytes of RAM for use by the payloads. The EIP RAM is dynamically allocated to meet the needs of the individual payloads. OOAM would require about 0.3 Mbytes of RAM per orbit. The MIL-STD-1553B data bus protocol is employed for the interface between the EIP and CDH, and between the EIP and the payload science/housekeeping data. Software for the CDH and EIP is written in C.

The spacecraft would use a 5 Watt Space Ground Link System (SGLS) transponder for communicating with ground control. The spacecraft would posses four quadrifilar helix antennas. Two of the antennas operate at S-band for the 32 kpbs and 1 Mbps downlinks; together, the two antennas provide omnidirectional coverage. Two of the antennas operate at L-band for the 1 kbps uplink, again providing omnidirectional coverage.

Ground contact with the spacecraft would be provided by the Air Force Satellite Control Network's (AFSCN) worldwide remote tracking stations (RTS). The RTS network would provide at least one contact with the spacecraft for every three orbits. Contacts would typically last 8 to 10 minutes, allowing ample time for downloading the EIP. The downloading of data from all three experiments would require 4 to 5 minutes.

Orbit position determination would be handled and computed by AFSCN. Like previous STEP missions, the candidate mission would employ an innovative approach to satellite ranging, making use of the spacecraft's SGLS transponder during a portion of the ground contact time when the transponder is not transmitting payload data from the EIP. As the spacecraft comes into view of an RTS, the RTS begins to send a pseudo-noise code to the spacecraft. This signal is echoed by the spacecraft's SGLS transponder during roughly the first 120 seconds of the contact; the delay between

transmission and echo measures the range. After 120 seconds, the spacecraft replaces the ranging signal with the payload data signal, at 1 Mbps. This continues until about 120 seconds before contact is lost, whereupon the spacecraft resumes transponding the ranging signal until contact is lost.

Once in orbit, control would be provided by the Air Force's SMC Detatchment 2 (formerly known as the Consolidated Space Test Center, CSTC). Satellite operations would be managed by CSTC's facility in Sunnyvale, California.

Summary

OOAM is a small, relatively light, simple, and robust instrument for measuring important properties of the stratosphere and mesosphere. It uses technology which has proven sycessful in POAM-II, modestly improved. OOAM, AURA and DDIDM would constitute compatible payloads for an STEP spacecraft. The STEP design and program philosophy provide significant cost savings in designing and interfacing the payloads, and in designing, fabricationg and launching the spacecraft.

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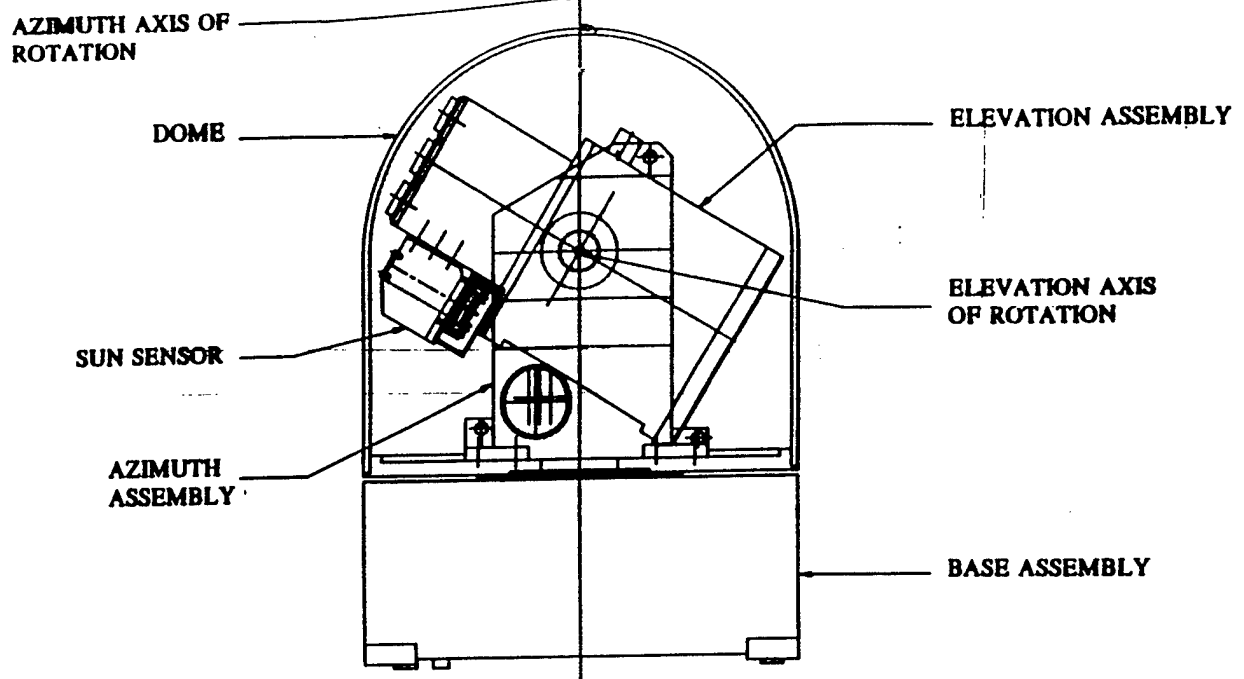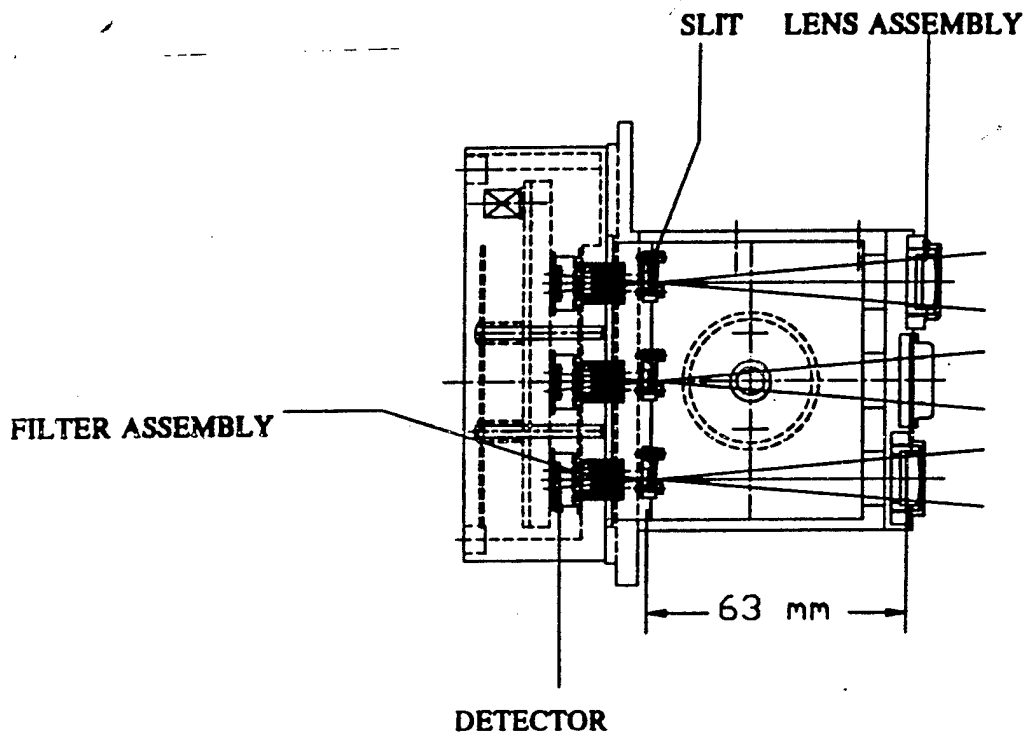
Figure 1. The *OOAM OHA*.

Figure 2. The optical train of the *OHA*.

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DDIDM (Dosimeter)

Solar Arrays (12x)

Separation Plane

Adapter Module

Core Module

Payload Module

DDIDM (Ion Drift Sensors)
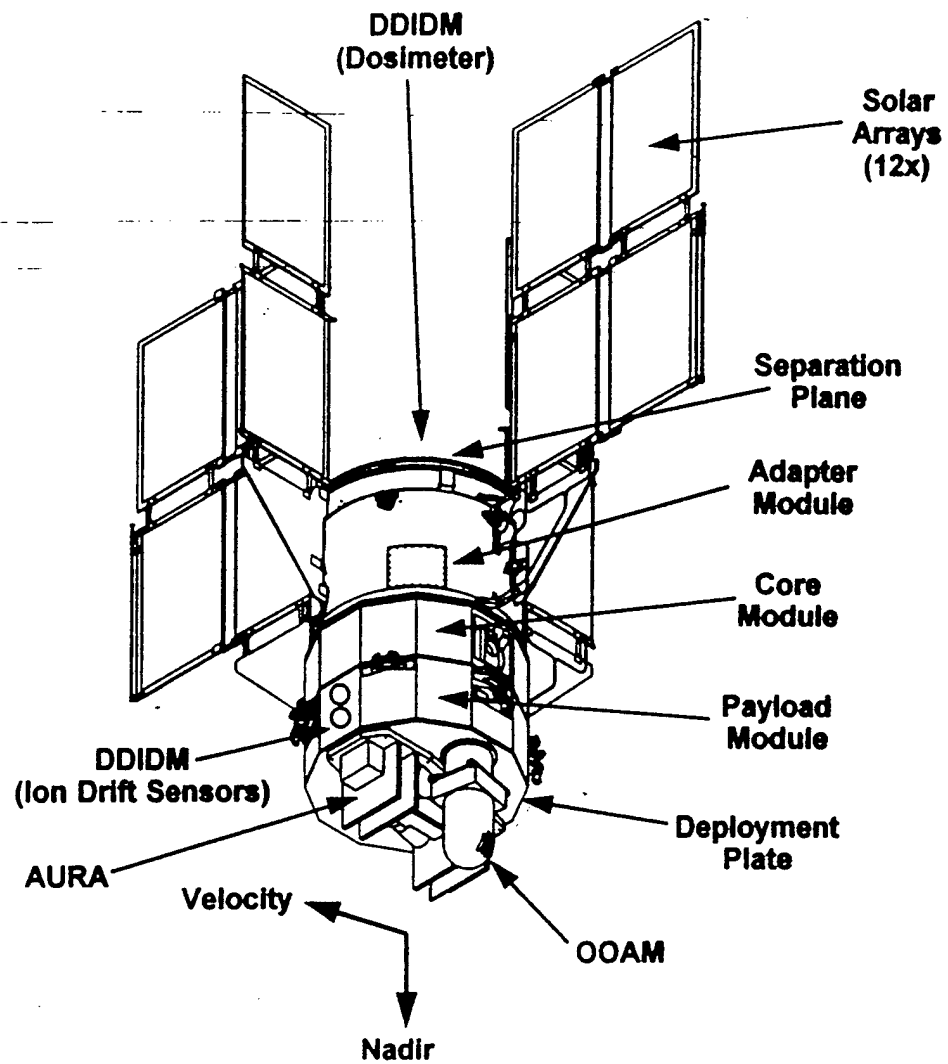
Deployment Plate

AURA

Velocity

OOAM

Nadir

Figure 3. Candidate *STEP* spacecraft configuration.